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(54) Turbine blade

(57) The blade has a metallic core 2 carrying the blade root 2a and a ceramic aerofoil 1 enveloping the core with a resilient substance 4, e.g. ceramic foam or felt, interposed between the core and aerofoil. The core 2 has a head 3 under which one or more shoulders 1e engage to secure the aerofoil 1. The blade may consist of several axial sections 1a, b, c. The core and aerofoil are thus able to expand and contract independently of one another. Cooling air passages 6a may be provided.

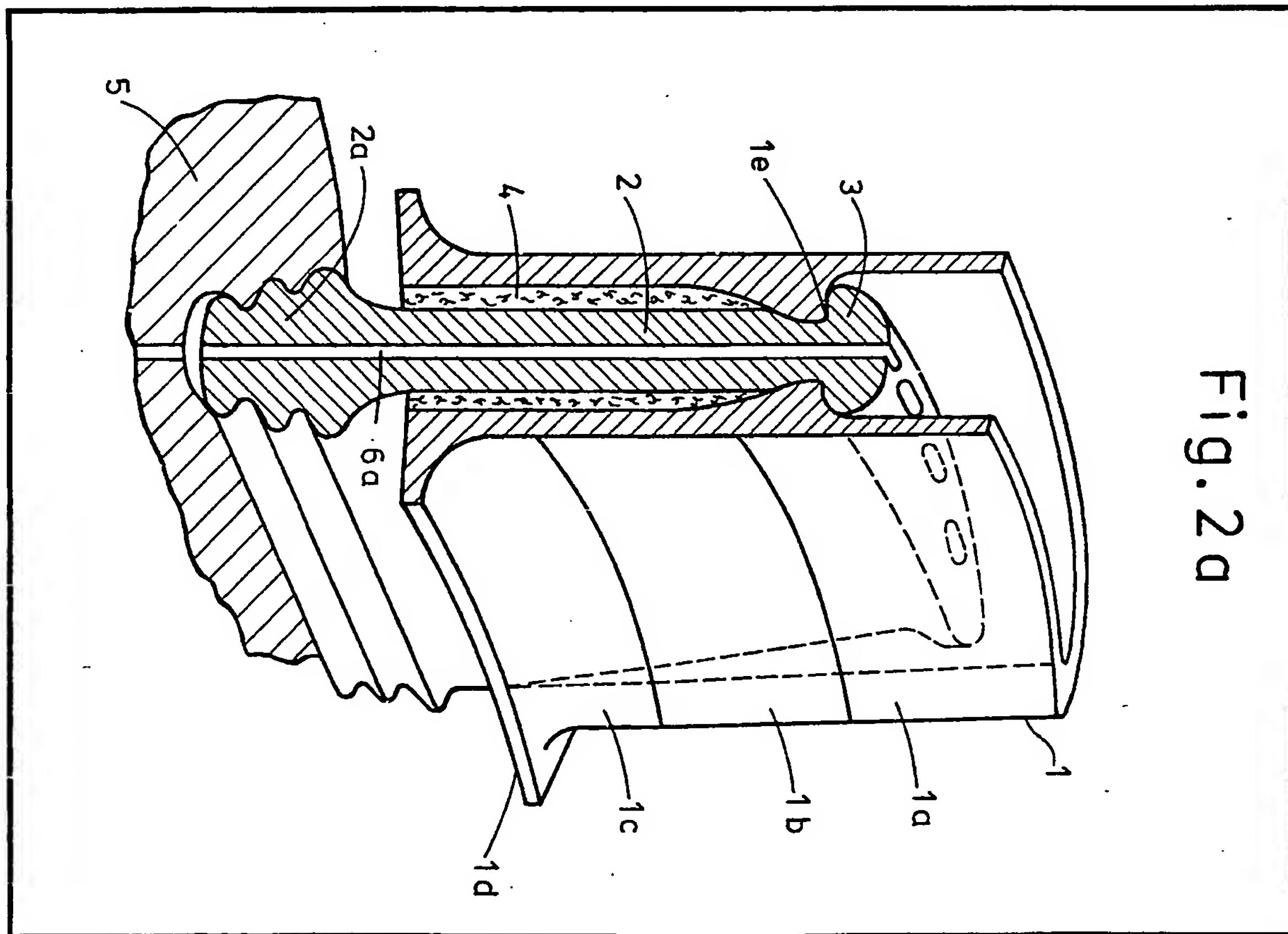


Fig. 2a

GB 2 027 496 A

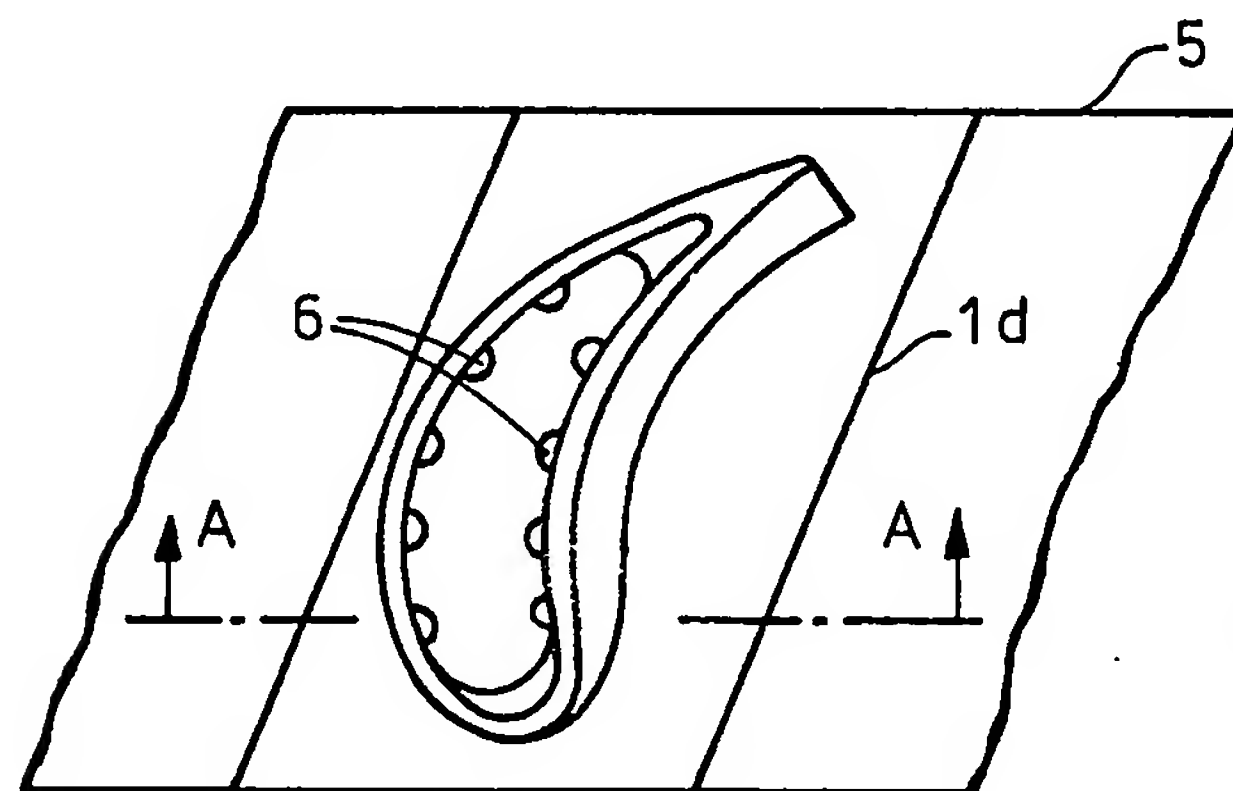
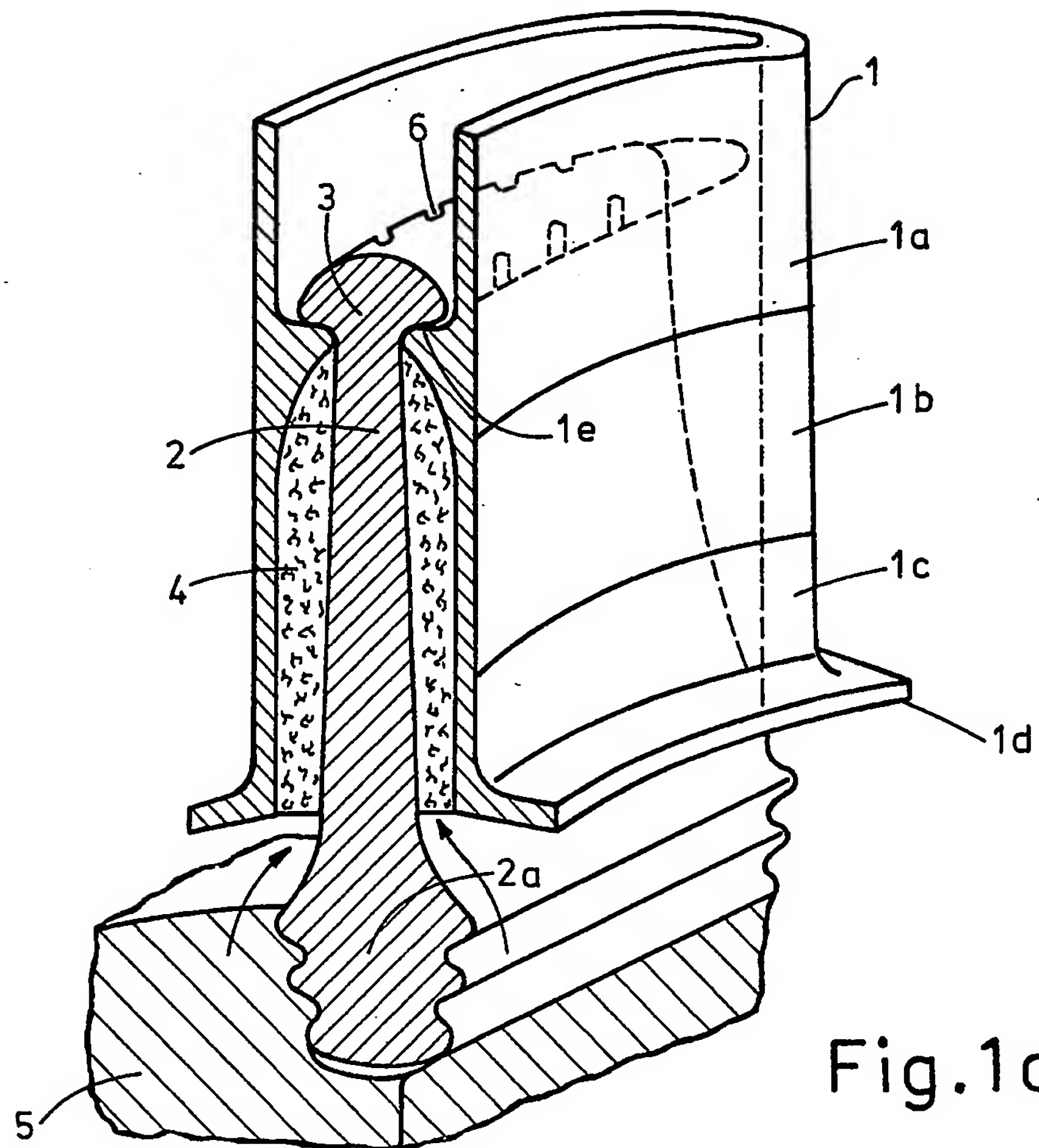


Fig. 2a

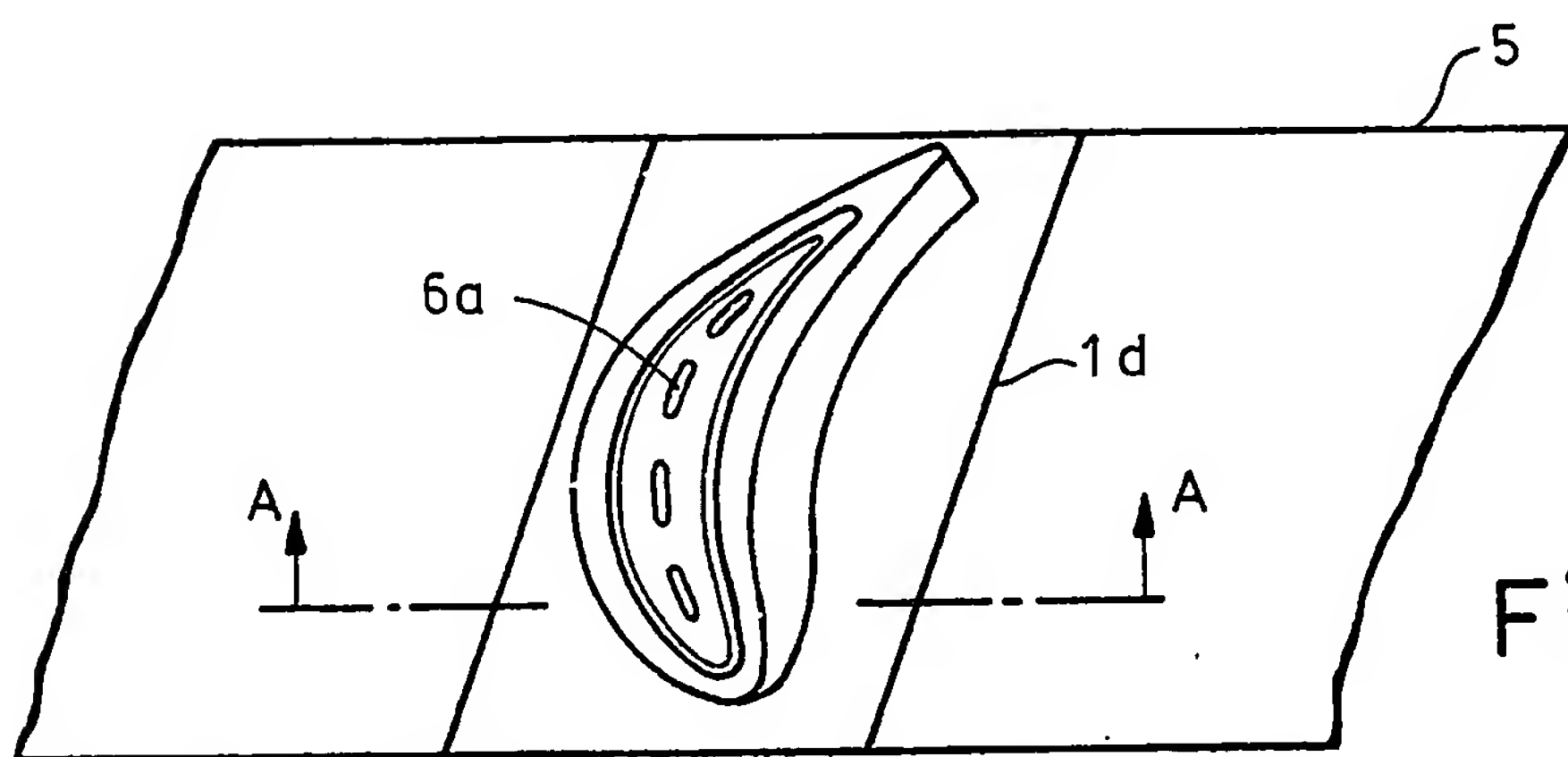
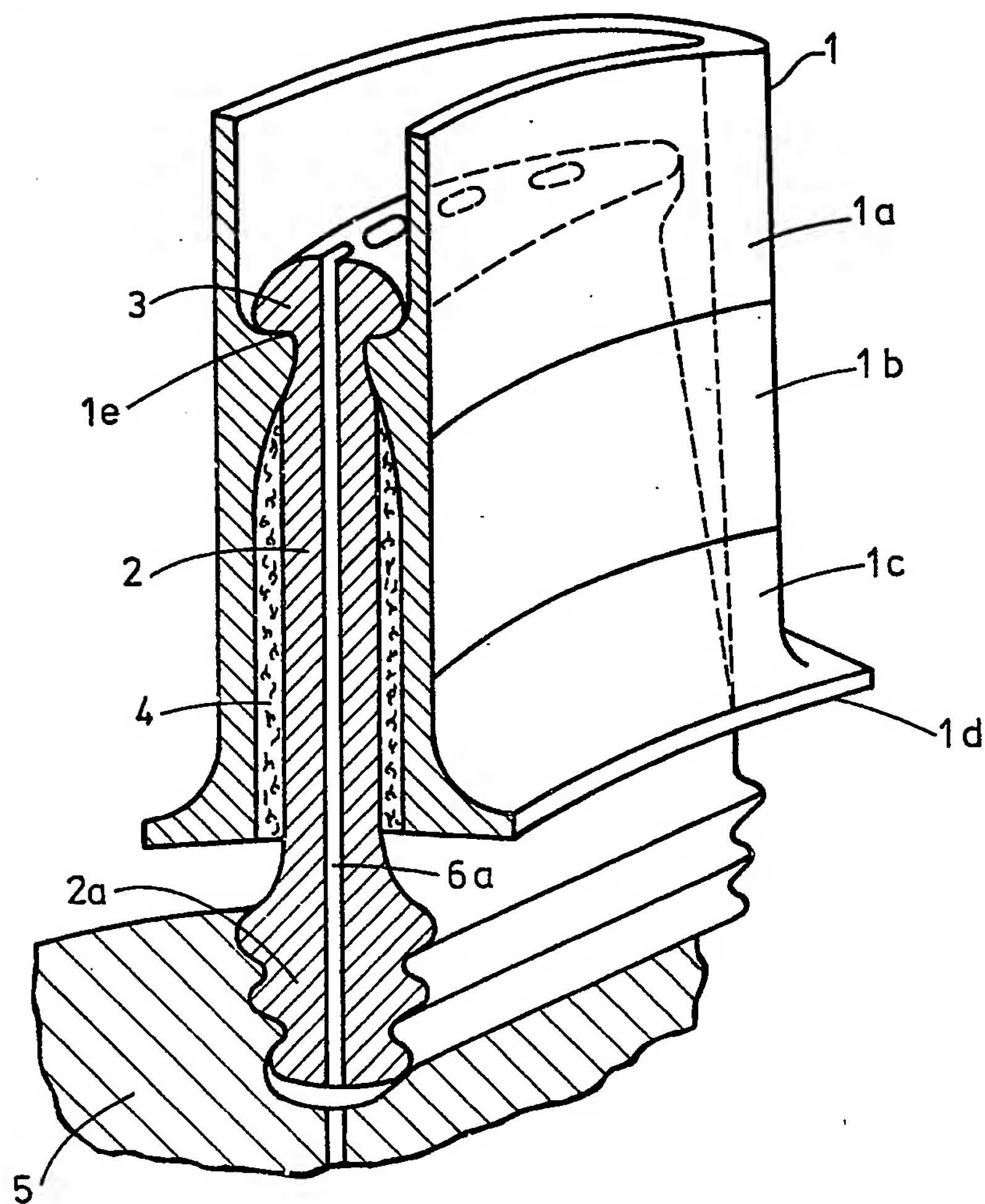


Fig. 2

Fig.3a

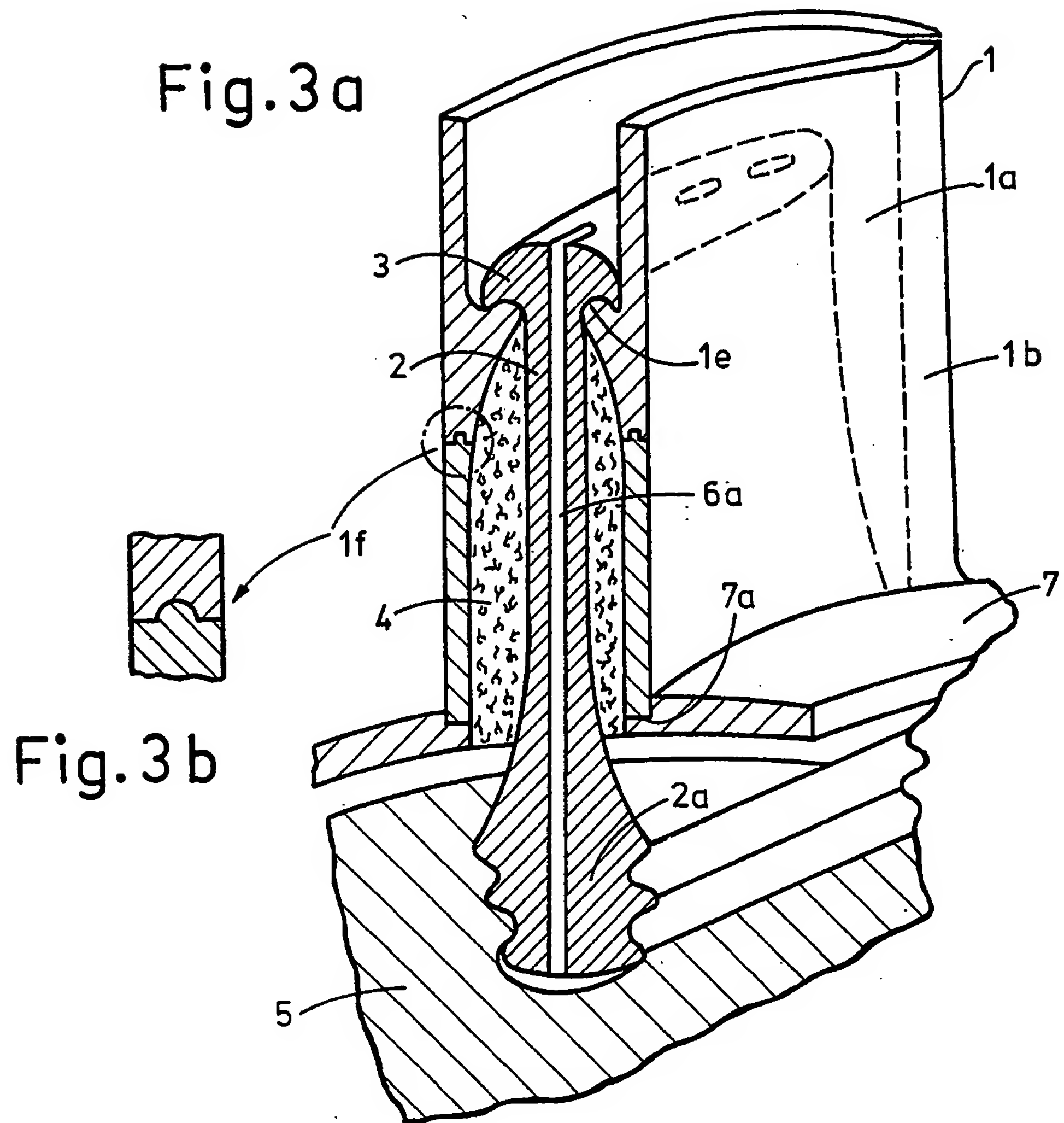


Fig.3b

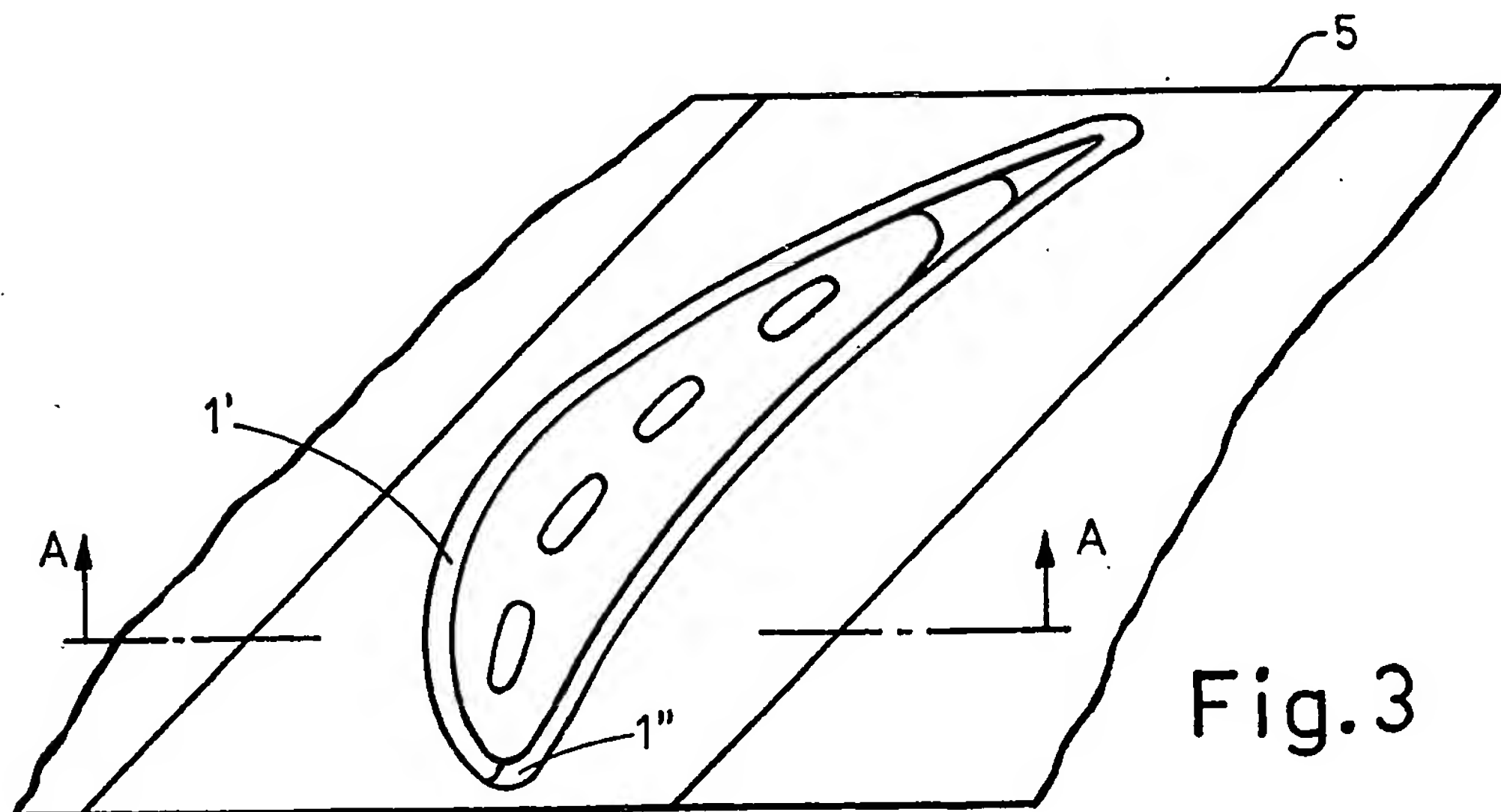


Fig.3

SPECIFICATION

Composite turbine blades

5 This invention relates to a turbine blade and, more particularly, to a blade comprising a ceramic aerofoil enveloping a metallic core.

10 An operationally safe joint between these two blade components is difficult to achieve since the materials have different thermal coefficients of expansion, because there is a risk of abrasion by centrifugal pressure and vibrations, and ultimately because of the risk of fracture of the brittle ceramic material, the ceramic aerofoil being able to withstand compressive but not tensile stresses. Even complex designs have failed to overcome this problem.

20 According to this present invention, we propose a turbine blade having a supporting metallic core carrying the blade root and a ceramic aerofoil enveloping the core with a resilient substance interposed between the blade, and the aerofoil, wherein the blade core comprises a head under which one or more shoulders projecting internally of the aerofoil, engage to secure the blade. By virtue of this arrangement, the core and the aerofoil are allowed to expand and contract independently of each other at different rates. Also, surfaces of the head and shoulders which abut one another are made large in the interest of maintaining moderate surface pressure. Further, the tensile load imposed on the ceramic part by centrifugal force is, in a blade according to this invention, extremely low.

35 The resilient substance, which is preferably permeable to air, acts to avoid radiation of heat from the aerofoil to the core. Also, the resilient substances affords friction between the aerofoil or aerofoil sections and the core tending to resist movement of the aerofoil or aerofoil sections.

45 Several embodiments of the invention will now be described by way of example with reference to the accompanying drawings of which:

Figure 1 is a plan view of a blade mounted on a rotor disc of gas turbine;

50 *Figure 1a* is a cross-sectional perspective view taken on line A-A of Fig. 1;

Figure 2 is a view similar to Fig. 1 but of another blade with modified cooling air ducts;

55 *Figure 2a* is a cross-sectional perspective view on line A-A of Fig. 2;

Figure 3 is a plan view of another gas turbine rotor blade;

Figure 3a is a cross-sectional perspective view taken on line A-A of Fig. 3, and

60 *Figure 3b* shows a detail of Fig. 3a.

The blade shown in Figs. 1 and 2 has a supporting metallic core 2 with, at its lower end, a serrated root 2a anchoring the blade in the turbine disc 5. Said metallic core is enveloped by a thin-walled ceramic aerofoil 1 and

carries at its upper end a head 3 beneath which engage shoulders 1e on the aerofoil near the upper end thereof.

70 The aerofoil consists of several axial sections 1a, 1b and 1c, the upper section 1a carrying the shoulders 1e. At its lower the blade has a pedestal 1d shaped such that there are only narrow gaps between the pedestals of adjacent blades mounted in a ring around the turbine disc. Between the blade core 2 and the aerofoil 1 is a resilient substance 4, such as ceramic foam or a felt made of ceramic fibres.

80 Cooling air ducts extending axially of the blade, are defined by grooves in the head 3 and the internal surface of the aerofoil envelope. These ducts 6 communicate via holes in the shoulders 1c with the resilient substance which for the purpose, may be made permeable to air.

85 In the arrangement shown in Figs. 2 and 3 the cooling ducts 6a are formed totally within the metallic core 2.

90 Referring now to Fig. 3, the aerofoil 1 is in two contoured parts, a part 1' presenting a convex external surface and a part 1'' presenting a concave external surface. The head 3 of the blade core 2 is undercut and the shoulders 1e are made complementary in shape to engage and hold together the two parts of the aerofoil.

100 The illustrated aerofoil is composed of sections 1a and 1b, connected by a mortise joint as illustrated in Fig. 3b. Naturally the topmost section 1a carries the internal shoulders 1e.

The lower end of the aerofoil section 1b is inserted in a recess 7a of a separate ceramic pedestal 7.

105 The head 3 of the blade core 2 is formed either by plastic deformation, diffusion welding or high-temperature brazing or else by mechanical machining after the aerofoil has been inserted from above, where its root 2a is shaped such that it will pass through the throat section of the aerofoil.

110 In a preferred embodiment, the core is detachably connected to the turbine disc and this may be in any conventional manner, for example by a dovetail or fir-tree root, but core may be integral with the turbine disc.

CLAIMS

1. Turbine blade having a supporting metallic core carrying the blade root and a ceramic aerofoil enveloping the core with a resilient substance interposed between the blade, and the aerofoil, wherein the blade core comprises a head under which one or more shoulders projecting internally of the aerofoil, engage to secure the blade.

2. A blade according to claim 1, wherein the abutting surfaces of the head and shoulders are plane.

3. A blade according to claim 1, wherein the aerofoil is in two parts the external surface

of one being convex and the other concave and in that the abutment surfaces on the head and on the shoulders are undercut to interlock in engagement.

5 4. A blade according to any one of claims 1 to 3, wherein the head and the shoulders are arranged near the upper end of the blade.

10 5. A blade according to any one of the claims 1 to 4, wherein the aerofoil consists of several axial sections optionally connected by mortise and tenon joins, the topmost section carrying the internal shoulders.

15 6. A blade according to any one of the claims 1 to 5, including a conventional arrangement of cooling air ducts.

7. A blade according to claim 6, wherein the cooling air ducts are defined between the blade core and the aerofoil.

20 8. A blade according to claim 6, wherein the cooling air ducts are formed totally within the core.

9. A blade according to any one of claims 1, 2 or 4 to 8, wherein the aerofoil comprises an integral pedestal.

25 10. A blade according to any one of the claims 1 or 3 to 8, and comprising a ceramic pedestal having a recess into which the aerofoil is received.

30 11. A blade according to any one of claims 1 to 10 wherein the resilient substance is permeable to air.

35 12. A blade according to any one of the claims 1 to 11, wherein the head of the core is formed by plastic deformation, diffusion welding or high-temperature brazing after fitting the aerofoil around the core.

40 13. A blade according to any one of the claims 1 to 11, wherein the head of the core is manufactured by mechanical machining, the root thereof being shaped such that it will pass through the aerofoil.

14. A blade according to the claims 1 to 13, wherein the core is integral with the turbine disc.

45 15. A blade according to any one of the claims 1 to 13, wherein the blade core is joined to the turbine disc by casting.

50 16. A blade according to any one of the claims 1 to 13, wherein the core is detachably connected to the turbine disc in a conventional manner.

55 17. A turbine blade constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.